Issues and Opportunities Related to the Production and Marketing of Ethanol By-Products

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Introduction

Fuel ethanol production is one of the fastest growing segments in American agriculture. Currently, there are 83 ethanol plants in production, with an additional 16 ethanol plants under construction. These ethanol plants have production capacity of 4.3 billion gallons of ethanol per year (Renewable Fuels Association, December, 2004). Approximately 40% of fuel ethanol is produced by wet-mills, and these plants produce wet or dried corn gluten feed, corn gluten meal, and corn germ meal as the primary by-products. Dry-grind ethanol plants represent the fastest growing segment of the fuel ethanol industry in the U.S., and produce the majority (60%) of fuel ethanol. By-products from dry-grind ethanol plants include wet and dry distiller's grains, wet and dried distiller's grains with solubles, modified "wet cake" (a blend of wet and dry distiller's grains), and condensed distiller's solubles. Of these dry-grind ethanol plant by-products, distiller's grains with solubles is the predominant by-product being marketed domestically. Several relatively new ethanol plants were designed and built without dryers. As a result, approximately 40% of the distiller's grains with solubles is marketed as a wet by-product for use in dairy operations and beef cattle feedlots. The remaining 60% of distiller's grains with solubles is dried (DDGS) and marketed domestically and internationally for use in dairy, beef, swine and poultry feeds. More than 7 million metric tonnes of DDGS will be produced in the year 2005. Some industry experts are predicting that DDGS production will reach 10 to 14 million metric tonnes within the next few years. Corn is the primary grain used in wet mills and dry-grind ethanol plants because of its high fermentable starch content compared to other feedstocks. However, some ethanol plants use sorghum, or blend corn with barley, wheat, or sorghum to make ethanol and distiller's grains with solubles, depending on geographical location, cost, and availability of these grains relative to corn. The beverage alcohol industry also produces grain by-products in the form of DDGS (whiskey distilleries) or brewer's grains (beer manufacturing). All of these by-products are nutritionally different from each other and have different economic value in various types of animal and poultry feeds. There are a wide variety of ethanol by-products available to livestock and poultry producers, but they vary in nutrient content, quality, and feeding value.

Issues/Challenges

There are several issues that make marketing and using distiller's by-products in animal feeds a challenge. Although the focus of this presentation is on DDGS, many of the same issues and challenges also apply to other distiller's by-products. The following 9 issues need serious attention if the U.S. ethanol industry is going to be successful in developing new markets for distiller's by-products. These issues are discussed in no particular order of priority.

1. Product identity and definition

Many people are confused about the terminology, production, and nutrient composition differences among various by-products derived from ethanol production. Different grains and grain mixtures, as well as processes, are used to produce beverage alcohol (beer and spirits) compared to fuel ethanol. By-products of these processes are defined in one of three major categories (i.e. distiller's products, maize products, and brewer's products) by the American Association of Feed Control Officials (AAFCO). However, many of these definitions were developed in the 1930's and 1940's to broadly encompass processes and by-products representative of the industry at that time. Many of these processes and by-products have changed considerably since these original definitions were adopted. Furthermore, there are several different processes being used within the fuel ethanol industry, resulting in variable levels of digestible nutrients in DDGS. For example, the proportion of the condensed distiller's solubles fraction added to the grains fraction before drying, varies substantially in the dry-grind ethanol industry. The relative proportion of these two by-product streams affects the protein, fat, and phosphorus content of DDGS.

There is no unique AAFCO term or definition for DDGS produced from beverage alcohol distilleries. However, the nutrient content and digestibility of DDGS produced by whiskey distilleries can be substantially different compared to DDGS produced from the new fuel ethanol plants. Some of the products listed in the AAFCO distiller's product definitions no longer exist today. Furthermore, new distiller's by-products are being developed (e.g high protein DDGS). Unless all of the current and new distiller's by-products are properly defined and differentiated among the wide variety of ethanol by-products, there will continue to be a considerable amount of confusion in the market, which will be a barrier to increasing their use in animal feeds. New distiller's by-product definitions are needed to help customers identify and understand the characteristics and quality of the various types of distiller's by-products available to the feed industry.

2. Variability in nutrient content, digestibility, and physical characteristics

When customers purchase DDGS, they don't always know the quality and nutritional value of the DDGS that they are going to get. There is considerable variation in nutrient content and digestibility, as well as physical characteristics among DDGS sources compared to soybean meal. Soybean meal is one of the main ingredients DDGS competes with to get into livestock and poultry feeds (Table 1). Notice that with the exception of the high variability in crude fat content among soybean meal sources (crude fat averages only about 1.9% in soybean meal), soybean meal produced by multiple processing plants is much less variable in nutrient content compared to DDGS. Feed industry nutritionists are less likely to purchase and use ingredients that vary substantially in nutrient content and quality because of the greater risk that livestock and poultry diets may not contain the desired level of nutrients to support optimal animal performance for their customers.

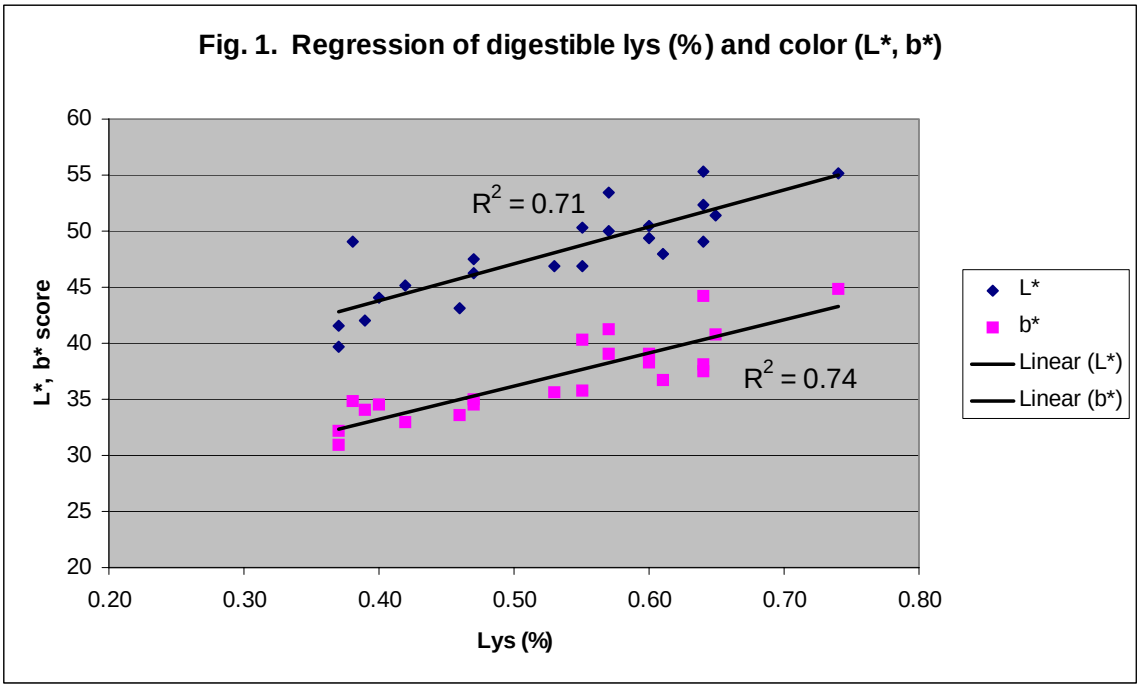
Research results from the University of Minnesota (Noll et al., 2003) have shown that the color of corn DDGS is highly correlated with true lysine digestibility in poultry (Figure 1). The lighter (L*) and more yellow (b*) the color of corn DDGS, the higher the lysine digestibility will be for poultry. Results from another study conducted at the University of Minnesota (Whitney et al., 2000) showed that dark colored corn DDGS sample had 0.0% apparent ileal lysine digestibility for swine, compared to 0.44% apparent ileal digestible lysine when a "golden" source of DDGS was fed to pigs.

Table 1. Comparison of the Variability (CV, %)[a] of Selected Nutrients in DDGS and Soybean Meal Among U.S. Sources.

Nutrient	DDGS[b]	Soybean Meal[c]
Crude protein, %	4.5	2.3
Crude fat, %	17.1	74.9
Crude fiber, %	18.9	9.5
Ash, %	27.2	6.6
Lysine, %	12.1	3.0
Methionine, %	8.5	5.3
Threonine, %	5.8	4.2
Tryptophan, %	12.0	7.3
Calcium, %	117.5	25.8
Phosphorus, %	19.4	9.1

[a] CV = coefficient of variation = (Standard Deviation/Mean) x 100
[b] 28 different U.S. DDGS sources sampled in 2004 (Source: www.ddgs.umn.edu)
[c] 84 samples from 3 upper Midwest sources and 3 Southeast sources sampled over 2 years (Source: Shurson et al., 2005. University of Minnesota, unpublished data)

Fig. 1. Regression of digestible lys (%) and color (L*, b*)



There is a wide range in color among DDGS sources in the U.S. ethanol industry. Although color appears to be a good predictor of lysine digestibility for corn DDGS, it is probably not a good predictor of amino acid digestibility in DDGS from other grain sources. Unfortunately, there are no quick, accurate, inexpensive tests to determine amino acid digestibility of DDGS sources at this time. Therefore, there is no way to make accurate diet formulation adjustments when using corn DDGS from various sources with differences in color. When DDGS is used in swine and poultry feeds, commercial feed mills must specify that they want "golden DDGS" when purchasing it, and identify suppliers that meet those criteria.

Particle size is also highly variable among DDGS sources, and can range range from 200 to 2100 microns. Feed manufacturers avoid using DDGS from sources that have very low average particle size because it doesn't flow through storage bins and feeders. Likewise, they also avoid DDGS sources that have a high average micron size (which is usually due to the presence of "syrup balls") because ingredient segregation can occur in complete feeds.

Flowability of DDGS is a significant problem for many ethanol plants in the industry. Particle size, the amount of residual sugars, and proper cooling of DDGS prior to loading affects the ability of the DDGS to flow out of feed bins, trucks, rail cars, and containers. This problem is most serious during hot, humid weather during the summer months and often results in a significant increase in costs due to increased labor and the extensive damage caused when attempting to unload the product.

The bulk density of DDGS is relatively low and quite variable (25 to 35 lbs/cubic ft.) compared to corn and other ingredients. Consequently, freight costs per unit of nutrients can be higher for DDGS compared to other ingredients. Attempts to increase bulk density by pelleting DDGS have been generally unsuccessful due to the lack of starch and relatively high amount of fat and fiber. Furthermore, pelleting increases the cost of the ingredient. Some commercial feed manufacturers will not use DDGS in pelleted diets because it significantly reduces mill throughput. A reasonable quality pellet can be made if it is blended with other ingredients such as soy hulls. However, when other ingredients are blended with DDGS, the nutrient composition of the product changes, and may make some customers skeptical of its quality and nutritional value.

3. Lack of a quality grading system and sourcing

Unlike corn and other grains, there is no grading system to differentiate quality within ethanol by-product categories, and many ethanol plants and marketers are opposed to developing such a system. However, despite not having a grading system for DDGS, there is price differentiation based upon subjective color evaluation. In fact, it is not uncommon to find a $20 to $30/ton market price differential between "golden" DDGS and darker colored DDGS. Without some type of system to differentiate among distiller's by-products with different nutritional and quality characteristics, customers who buy DDGS on the open market are frequently disappointed when shipments arrive and the product doesn't meet their expectations. This is very common in the export market where DDGS is a new and unfamiliar ingredient. There is no formal mechanism for helping export customers identify DDGS sources that supply the quality that they desire. This is a critical problem that needs to be addressed to sustain the DDGS market.

4. Lack of standardized testing procedures

There are no standardized testing procedures to determine nutrient content of DDGS. As a result, there are an unnecessary number of claims regarding DDGS not making a guaranteed specification. One would think that determining something as simple as moisture content would be very straight forward and provide repeatable results among laboratories. However, this is not the case. Depending upon the laboratory procedure used, the moisture value determined can vary by 1.5 to 2 percentage points within the same DDGS sample. This occurs because some commercial laboratories use a standard method of oven drying for 1 hour at 130° C compared to other laboratories using approved procedures involving drying 4 hours at 104° C or drying for 24 hours at 70° C. The 130° C drying method routinely overestimates the moisture content by 1.5 to 2%.

Many DDGS customers are unaware that the use of ELISA tests to detect the presence of mycotoxins in DDGS can result in a high percentage of false positive readings. Furthermore, unlike for soybean meal and other feed ingredients, there are no designated referee laboratories for DDGS producers, marketers, and customers to use to resolve issues related to product not meeting guaranteed nutrient specifications. Standardized testing procedures (AOAC) must be identified and used to reduce variation in analytical results being reported among laboratories. Once standardized procedures are identified, the commercial laboratories that adopt these standardized procedures could be used as referee laboratories for distiller's by-products.

5. Quality management and certification

There is a paradigm shift that is beginning to occur in the U.S. ethanol industry. Bankers and investors of ethanol plants that are being planned, are under construction, or have recently started operation, recognize that 15 to 30% of the revenue stream of an ethanol plant is from the sales of distiller's by-products. As a result, bankers and investors are forcing ethanol plant owners and managers to find distiller's by-product marketers that are more customer sensitive, and to develop quality management procedures to ensure the production of more consistent, high quality by-products. However, on the other end of the spectrum, there are producers and marketers of distiller's by-products who are unaware or unconcerned about customer needs relative to product quality and consistency. They simply want to "get rid of it" at a competitive price without spending additional time, effort, and money to deal with needs and demands of their customers. Currently, there are no distiller's by-product quality standards in the ethanol industry.

Commercial feed mills and livestock and poultry producers are the DDGS customers. The decision to purchase and use DDGS in livestock and poultry feeds is made by nutritionists. Nutritionists select and purchase feed ingredients based upon price, as well as predictability and consistency in quality and nutrient content, in order to minimize the risk of not meeting desired nutrient levels in manufactured complete feeds. Many commercial feed mills and large livestock and poultry operations are ISO certified and have implemented extensive total quality management programs. These operations select their feed ingredient suppliers based upon whether they can deliver a consistent product with every order, and use some type of quality management program (and preferably be ISO certified).

Many domestic and international customers are demanding more product guarantees than those that are currently used in the DDGS market (i.e. moisture, fat, fiber, protein). These customers want more guarantees for the DDGS that they purchase because of previous bad experiences dealing with the high variability in DDGS quality. In Europe, an International Feed Ingredient Standard (IFIS) quality assurance scheme will be introduced this in 2005. It will require that feed ingredient exporters be GMP (good manufacturing practices) certified. Therefore, if DDGS and other distiller's by-products are going to continue to be exported to the EU (currently is the largest importer of DDGS from the U.S.), ethanol plants will need to be certified to meet these standards. Attempts have been made to develop and implement an independent, third party, voluntary DDGS certification program in Minnesota, but this program has not been implemented. Decision makers in other major ethanol producing states are having similar discussions. It seems logical, based upon the needs and demands of the international feed industry, that a voluntary national DDGS certification program be developed and implemented, rather than each state developing its own certification program.

6. Transportation

Transportation infrastructure and costs are having a large impact on the ability to successfully market DDGS. In August 2004, the Burlington Northern and the Union Pacific railroads increased their rates and no longer allowed the use of their system cars to transport DDGS. Leasing rail cars is too expensive. Therefore, the only way to use rail as a mode of transportation is for the marketing group to own their own cars. However, smaller ethanol plants (18 to 30 million gallon plants) do not generate enough volume in a short period of time to use unit trains.

The export market is greatly affected by the transportation system. Marketers that own their own rail cars are unwilling to allow them to cross the Mexican border to deliver DDGS to that export market because of the loss of control, and the uncertainty of when they will be returned after they have been unloaded. Delivering DDGS by rail into Canada, especially Ontario, is also problematic because much of the rail system in that province has been eliminated. Transloaders in the Pacific Northwest have refused to handle DDGS (with the exception of DDGS coming from one or two sources) because of flowability problems. Therefore, loading containers near the production facilities and then transporting them to the west coast for shipment to the export market will likely becoming a necessary alternative for meeting demand in the Asian export market.

7. Research, Education, and Technical Support

Research sells distiller's by-products. In general, the U.S. ethanol industry has not been willing to invest enough funds in research to generate the necessary information needed to build new markets. With one exception, there has been no industry wide checkoff system to generate funds to support research and education on the use of distiller's by-products in livestock and poultry feeds. Eight years ago, a small group of ethanol plants in Minnesota became concerned about the projected growth of the ethanol industry and the need to expand the market for DDGS. This group of ethanol plants implemented a voluntarily checkoff program to help fund a portion of the DDGS research conducted at the University of Minnesota on swine and poultry. Individual state corn grower associations also provided a portion of this research funding in recent years. This limited amount of funding has had a profound impact on increasing DDGS usage in the swine and poultry industries. In 2001, the total DDGS usage in swine and poultry feed was estimated to be only 4%. However, in 2004, DDGS usage in U.S. swine and poultry feeds increased to 19% of the total DDGS produced. This is remarkable because DDGS production also doubled during this time period. This occurred as a result of using these research results to educate new customers regarding the advantages and limitations of this feed ingredient. The U.S. ethanol industry must invest in research and education to further develop these and other new potential markets. Research and education on the use of distiller's by-products should be the responsibility of the entire industry.

8. International market challenges

Developing a significant DDGS export market is a significant challenge that requires extensive education and ongoing technical support. Export customers complain about the lack of availability of a consistent supply, poor customer service from U.S. suppliers, and difficulty in finding reliable exporters that market high quality, golden DDGS. To solve this problem, either a system that differentiates quality and value (e.g. grading system) must be implemented, or a system to directly connect customers to specific sources needs to be developed. Some export customers have the perception that the export market is a "dumping ground" for low quality U.S. ingredients based upon bad experiences with the quality of the product they have received. Part of this unfavorable image is due to the fact that a few

DDGS suppliers misrepresent DDGS quality and nutrient specifications, or blend DDGS with other ingredients.

On the other hand, U.S. suppliers don't know and may mistrust export customers because some customers back out of commitments when the price decreases. Some U.S. suppliers view the export market as a residual market and only export when there is a surplus in the domestic market. The amount of documentation and time required to meet foreign government import requirements are additional challenges that DDGS exporters face. Product definition and tariff structures in some countries also make it difficult to build export markets for DDGS.

9. Lack of a national distiller's by-product organization and industry cooperation

The U.S. ethanol industry is comprised of a few very large producers and many small, independent ethanol plants. Although there are a few examples of small groups of ethanol plants working together to fund university research to develop new information to expand the DDGS market, there is no national organization that coordinates and addresses issues related to DDGS production, research, education, and marketing for the entire industry. The Renewable Fuels Association is the national organization that serves the ethanol industry, but has not addressed the issues related to marketing and use of the by-products. Some efforts are currently being initiated (U.S. Grains Council, National Corn Growers Association, and the USDA Federal Grain Inspection Service) to explore the possibility of addressing these industry-wide issues.

Opportunities

The fear of producing more DDGS than feed industry can consume has not yet been realized. This is partly due to research and education that has been conducted to develop non-traditional markets (poultry and swine) domestically and internationally. In order to continue to increase DDGS usage in non-traditional markets (e.g. swine and poultry), stricter product quality guidelines must be developed and met in order to sustain and grow these markets. More funding for research and education is needed to continue building markets as the U.S. ethanol industry grows and DDGS production continues to increase.

Most of the recent growth in the ethanol industry has occurred in the western Corn Belt of the U.S. where there is an abundance of corn and a high concentration of livestock and poultry operations. As a result, there is significant market growth potential for DDGS near these new ethanol plants. Currently, the U.S. ethanol industry is producing approximately 7 million metric tonnes of DDGS. On a theoretical basis, if every broiler, layer, and turkey in the U.S. ate 0.10 lbs of DDGS per day, 8 million metric tonnes of DDGS would be required. Likewise, if every pig in the U.S. ate 0.84 lbs of DDGS per day, or each beef steer, cow and calf ate an average of 4.8 lbs of DDGS per day, or if every dairy cow ate 8 lbs of DDGS per day, 8 million metric tonnes of DDGS would disappear. In other words, the livestock and poultry industries in the U.S. have the potential to consume all of the DDGS produced. However, many of these potential customers are often unfamiliar with the nutritional characteristics of DDGS and other distiller's by-products, and how to use them successfully in animal feeds. A significant amount of education and technical support is needed to help these inexperienced users develop feeding programs using DDGS. However, education alone will not be enough. The ethanol industry must understand their customer needs and address their concerns by modifying their production, quality management, and product technical support procedures if they want to maintain their markets.

It is becoming increasingly critical that the issues related to variability in nutrient content, nutrient digestibility, variation in physical characteristics, multiple distiller's product characteristics, standard product testing procedures, certification and other quality concerns be addressed for long-term, sustained demand by domestic and international DDGS customers. To do this, a national DDGS organization, consisting of technical experts who understand customer needs to be developed to begin finding solutions to the many issues and challenges that exist in the ethanol industry today. The growth of the domestic and export market for DDGS and other distiller's by-products is dependent upon the interest and ability of the ethanol industry to address the issues and challenges described in this paper.